



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)



Spectrum and Capacity Analysis for Air/Ground Air Traffic Management Communications

May 3, 2007

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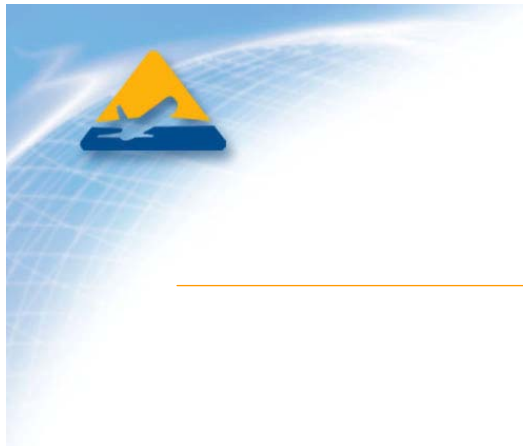
Bruce Eckstein, FAA

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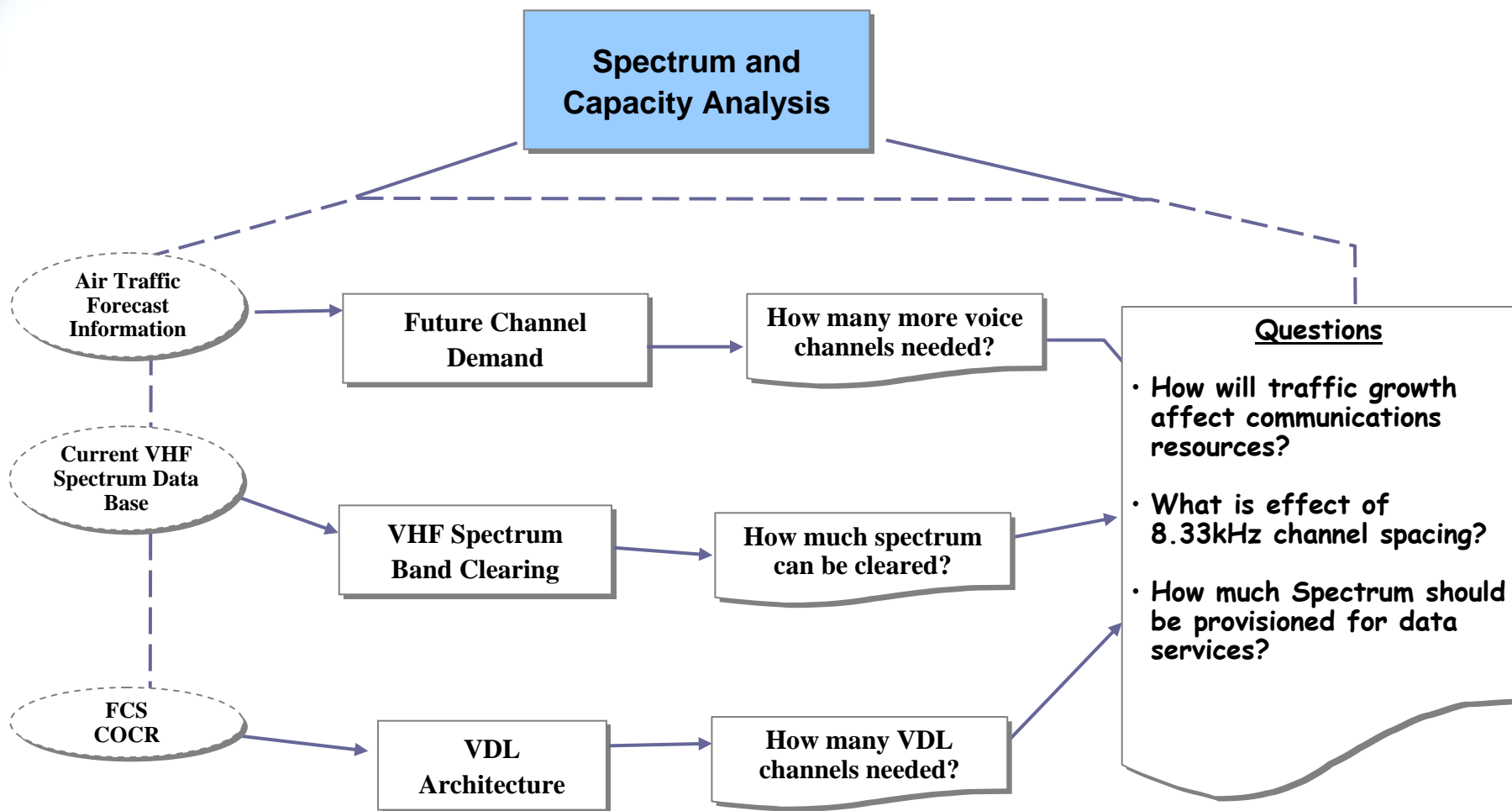


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F043-B07-006



Introduction

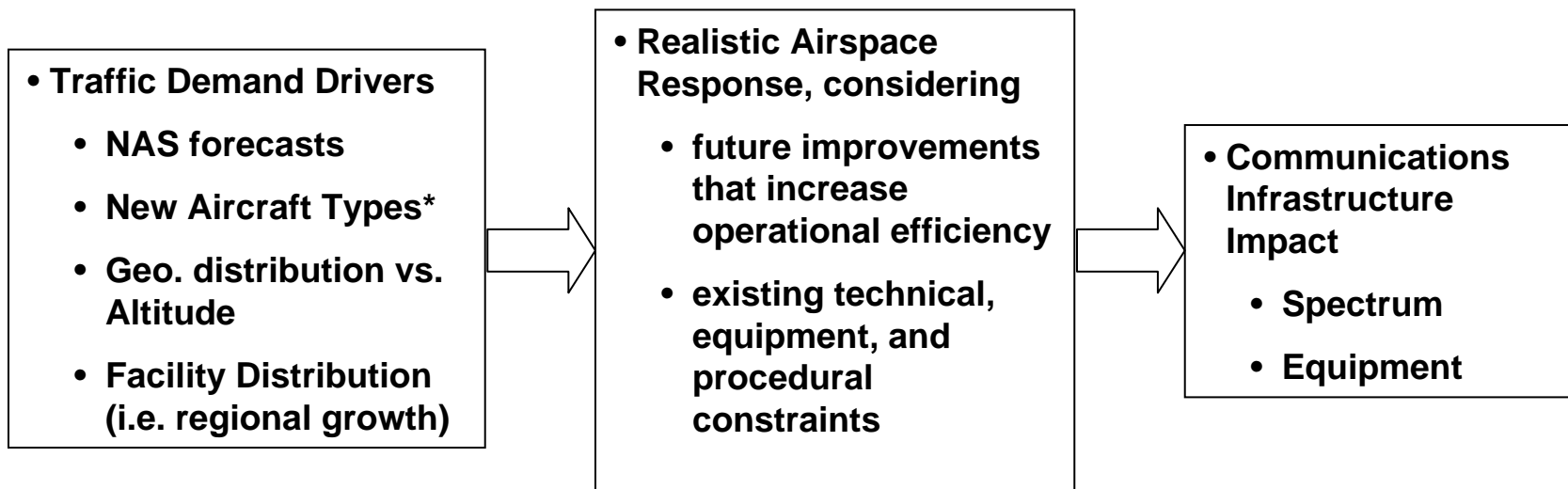




Future Demand for Voice Communications – 2005-2015



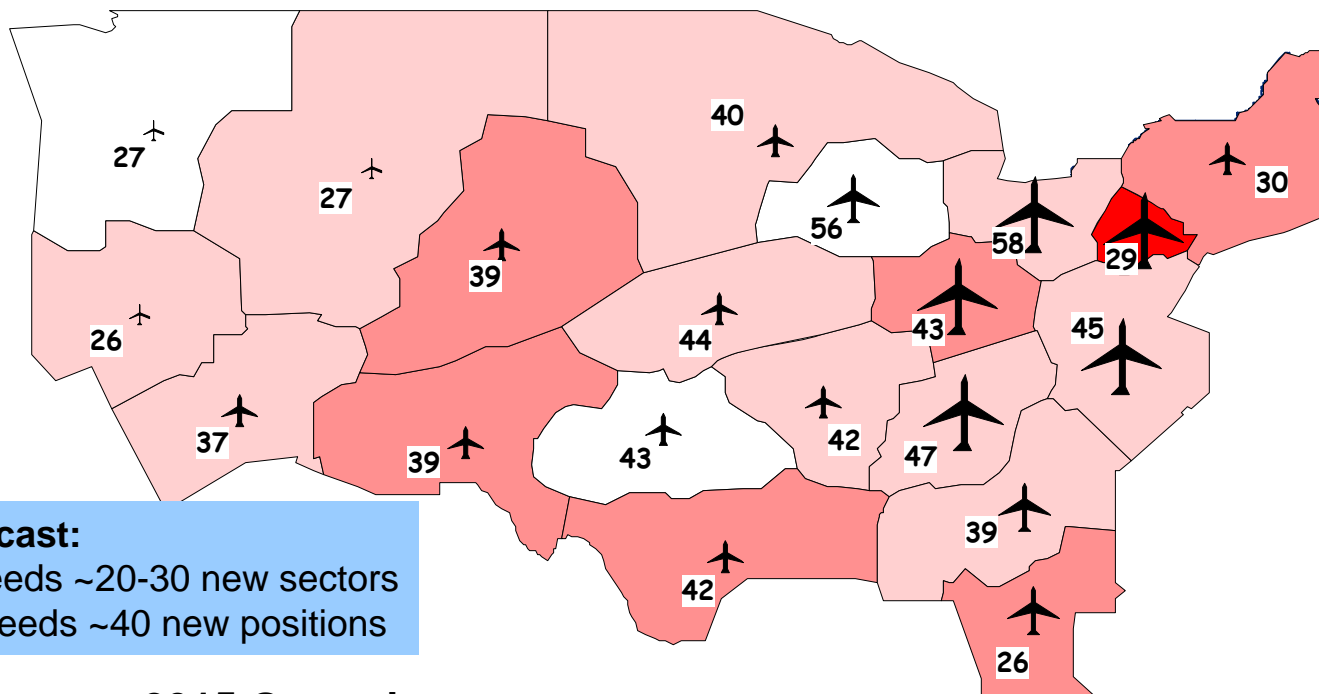
- **Approach:**



* Very Light Jets (VLJs),
Unmanned Aerial Systems (UASs) and
Space Operations







Projected IFR Aircraft Operations and Growth in 2015 by En Route Center







2015 Forecast:

Enroute needs ~20-30 new sectors
Terminal needs ~40 new positions

Forecast 2015 Operations

	3.75M – 4.5M (5)
	3.0M – 3.75M (3)
	2.25M – 3.0M (9)
	1.4M – 2.25M (3)

Percent Growth from 2005 to 2015

	34 to 40	(1)
	28 to 34	(6)
	22 to 28	(10)
	16 to 22	(3)

nn – Number of ARTCC Sectors - 2005



Subband Clearing - Objectives



- Determine how many ATS channels in a subband can be cleared for potential *aeronautical data communications* use
- Determine the impact of subband clearing on the remaining capacity of the *voice system* to support future requirements
- Determine subband clearing results under different voice system scenarios
 - All 25kHz AM (as today)
 - En route converted to 8.33 kHz



Summary of Bandwidth That Can Potentially be Cleared



Simulated Voice Channel Scenario	Contiguous Clearable Bandwidth*
All-25AM	0.75–1.3 MHz
En Route 8.33	3–4 MHz

*Across various scenarios



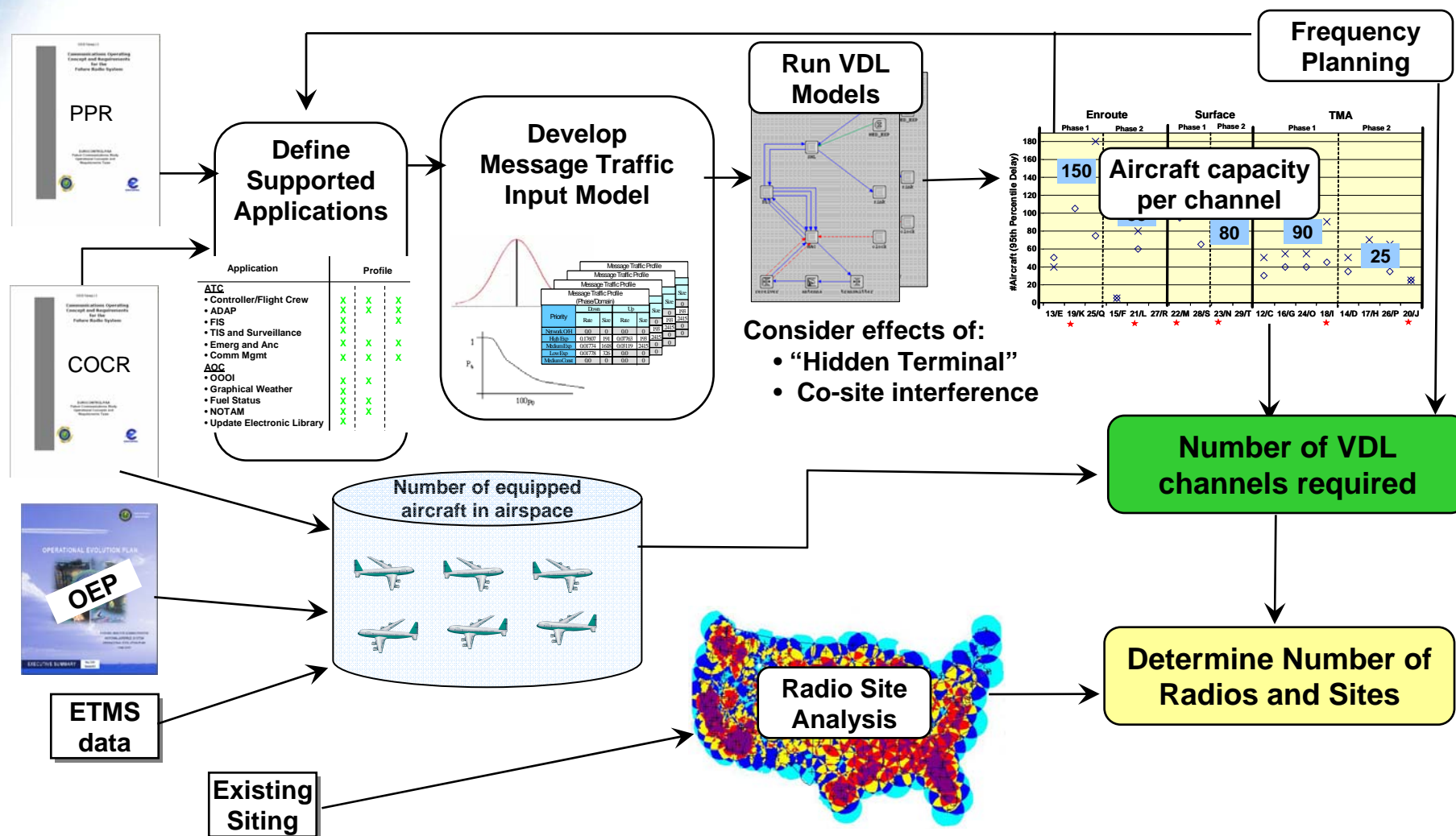
Subband Clearing – Remaining Voice Growth Capacity

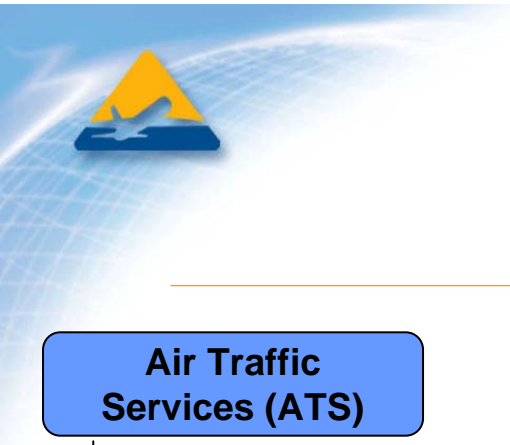


- **All-25 AM scenario**
 - Geographical concentration of the future en route circuits will heavily influence size of clearable subband below 136 MHz
 - Distribution of future en route circuits results in little remaining capacity (50 to 205 circuits)
- **En route 8.33 scenario**
 - Clearing 3.75 MHz below 136 MHz leaves approximately 250 circuits remaining
 - Clearing 3 MHz instead of the maximum leaves approximately 1,000 circuits remaining

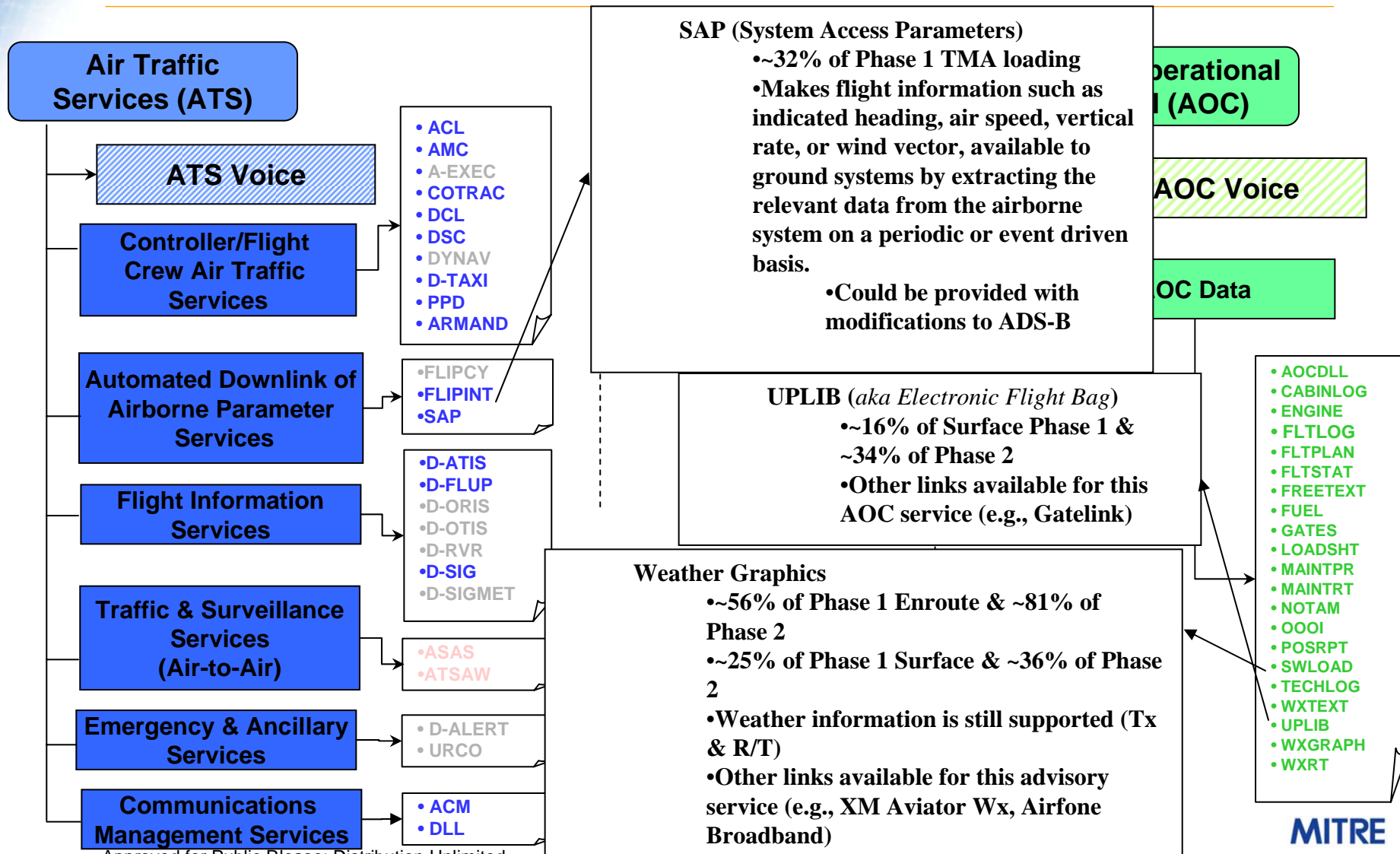


Data Communications Assessment





PPR-Filtered COCR-Defined Services





Application By Segment

Year Equipage	2017 60%	2022 75%	2027 85% T/100% E
<u>Application</u>	<u>Segment 1</u>	<u>Segment 2</u>	<u>Segment 3</u>
ATC Clearance Service (ACL)	X ¹	X	X
ATC Microphone Check (AMC)	Free-Text	X	X
Common Trajectory Coordination Service (COTRAC)			
(Initial 4D in Mixed Airspace)	X ²	X ²	X
(4D in Perf-based Airspace)		X ²	X
(Widespread 4D down to Paired App)			X
Data Link Logon Service (DLL)	X	X	X
Data Link Automatic Terminal Information Service (D-ATIS)	X	X	X
Departure Clearance Service (DCL)	X	X	X
ATC Communications Management Service (ACM)	X	X	X
Data Link Taxi Service (D-TAXI)			
Departure	Coded	X	X
Arrival		X	X
Arrival Manager Information Delivery Service (ARMAND)	X	X	X
Pilot Preference Downlink (PPD)		X	X
Down Stream Clearance (DSC)		X	X
Flight Path Intent Service (FLIPINT) (aka ADS-C)		X	X
System Access Parameters Service (SAP)		X	X
Data Link Flight Plan Update Service (D-FLUP)		X	X
Data Link Surface Information Guidance (D-SIG)			
Uplink of Static Airport Map		X	
Augmented Surface Map Update			X
S&M, C&P, ITP			X
Paired Approaches (PAIRAPP)			X
Wake Vortex Footprint (WAKE)			X

1. ACL Msg size increased due to limited COTRAC
2. COTRAC Msg size decrease for simpler trajectories

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F043-B07-006



Frequency / Sites / Transceivers



	# Frequencies			# Sites			# Transceivers			
	Enroute	TMA	Surface	Enroute	TMA	Surface	Enroute	TMA	Surface	CSCs
Seg 1	12	0	3	220	0	148	~ 220	0	148	368
Seg 2	36	21	3	242	63	148	~ 495	270	148	390
Seg 3	36	22	6	242	91	148	~ 600	342	198	390

Total Subband: Seg 1: ~ 0.41 MHz
Seg 2: ~ 1.71 MHz
Seg 3: ~1.95 MHz

Initial results show 481 sites, although likely to be able to share between domains 390 sites, if you assume TMA transceivers are cosited with Airport transceivers

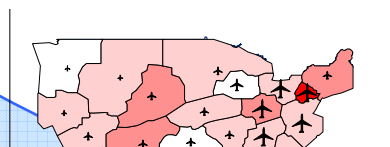
- Assumes no overlap in frequencies between domains
 - There are unutilized frequencies within the reuse pattern that may be usable in other domains
- Assumes ATS+AOC traffic on the same channels
- Assumes subbanding and 115 nmi enroute service volumes
- Subband includes 10% channel margin but not 25/100kHz guard band(s)
- Does not account for possible frequency needs associated with multiple service providers



Summary



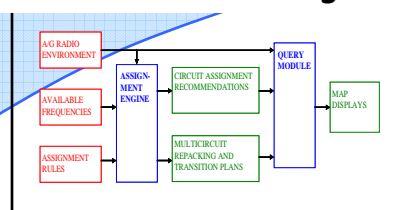
Future Demand Assessment



- Segment 1 should be supportable keeping 25kHz voice channels
- Segments 2 & 3 likely require some voice channels to adopt 8.33 KHz channelization to free sufficient spectrum

Projected Spectrum availability and VDL Needs through NextGen time frame

Spectrum Band Clearing Study



Retain 25 kHz AM

VHF Comm
117.975 MHz – 137.000 MHz

2015

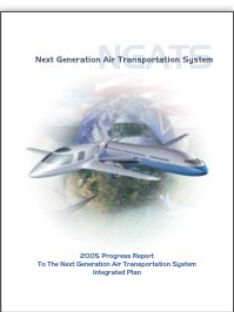
1 MHz

Potential 8.33 AM

VHF Comm
117.975 MHz – 137.000 MHz

2030

4 MHz





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